

Demagnetization of cubic Gd-Ba-Cu-O bulk superconductor by cross-fields: measurements and 3D modeling

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Introduction

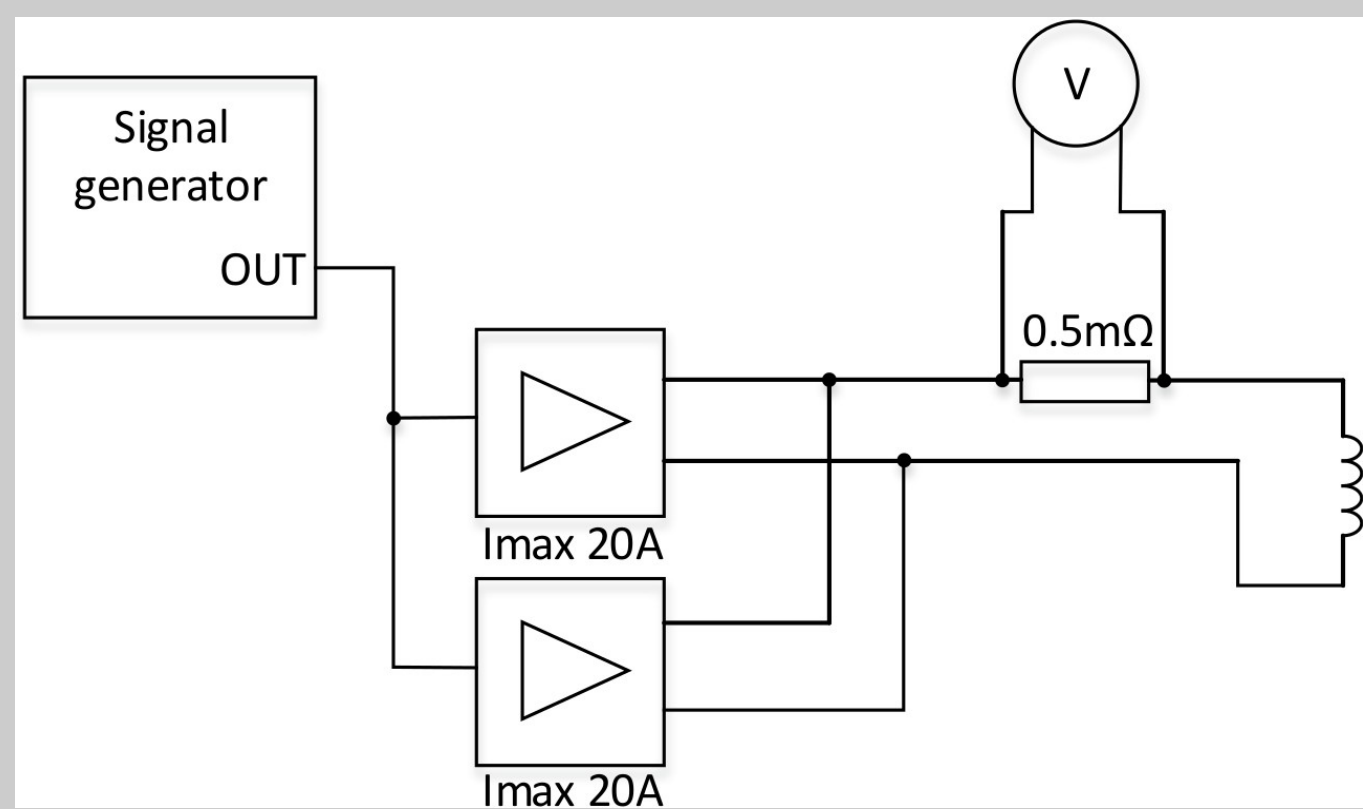
The effects of finite size and cubic shape of the sample are not well understood

Calculation of cubic bulk demagnetization by cross-field needs 3D modeling

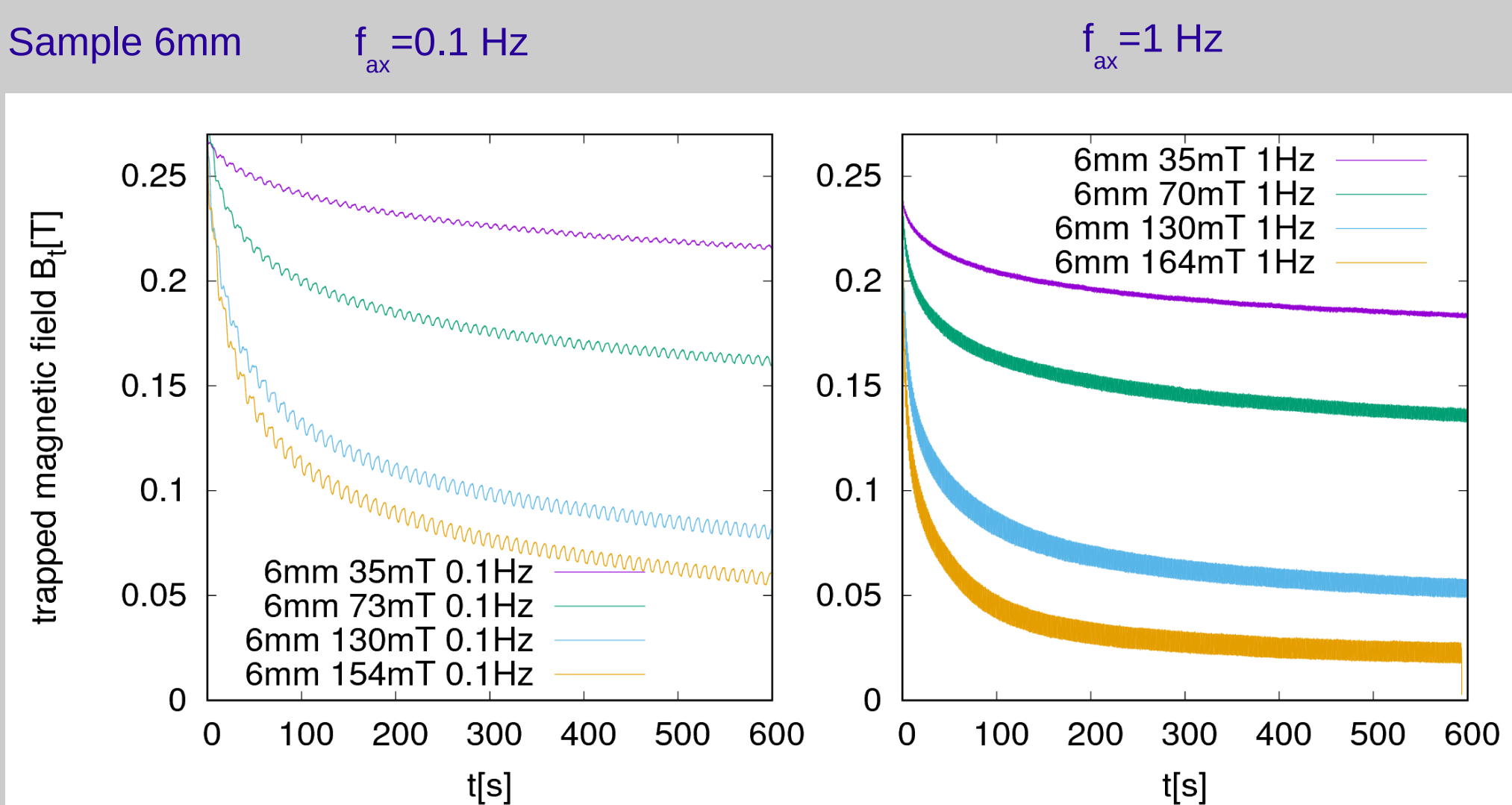
Minimum electro magnetic entropy production method 3D (MEMEP 3D) avoids discretization of air

3MP5-08

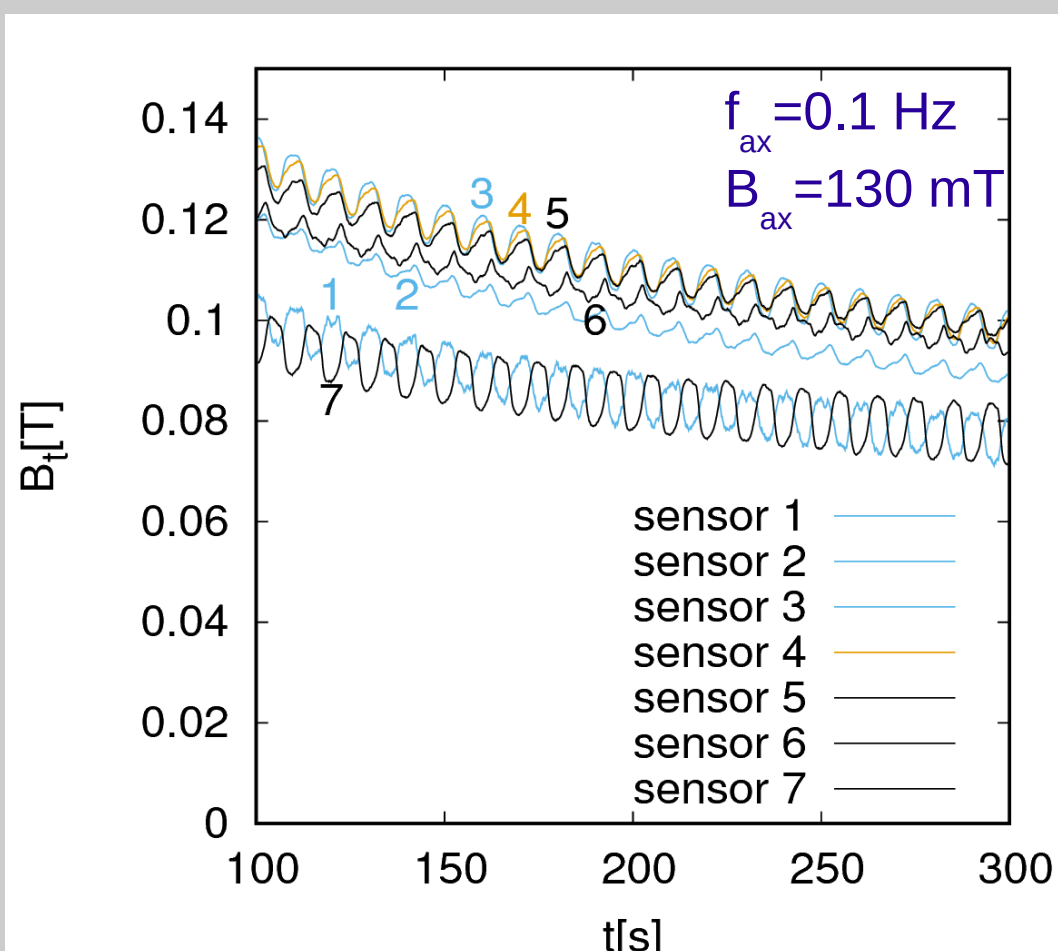
Measurements after Field cool



Cubic sample
Width 6 mm
Material GdBaCuO+AgO
 B_{az} 1.3 T
Ramp rate 13 mT/s
 B_{ax} 35-164 mT
 f_{ax} 0.1-1 Hz
Relaxation 900 s
 B_t 270 mT



Asymmetry of trapped field between 1st and 7th sensor

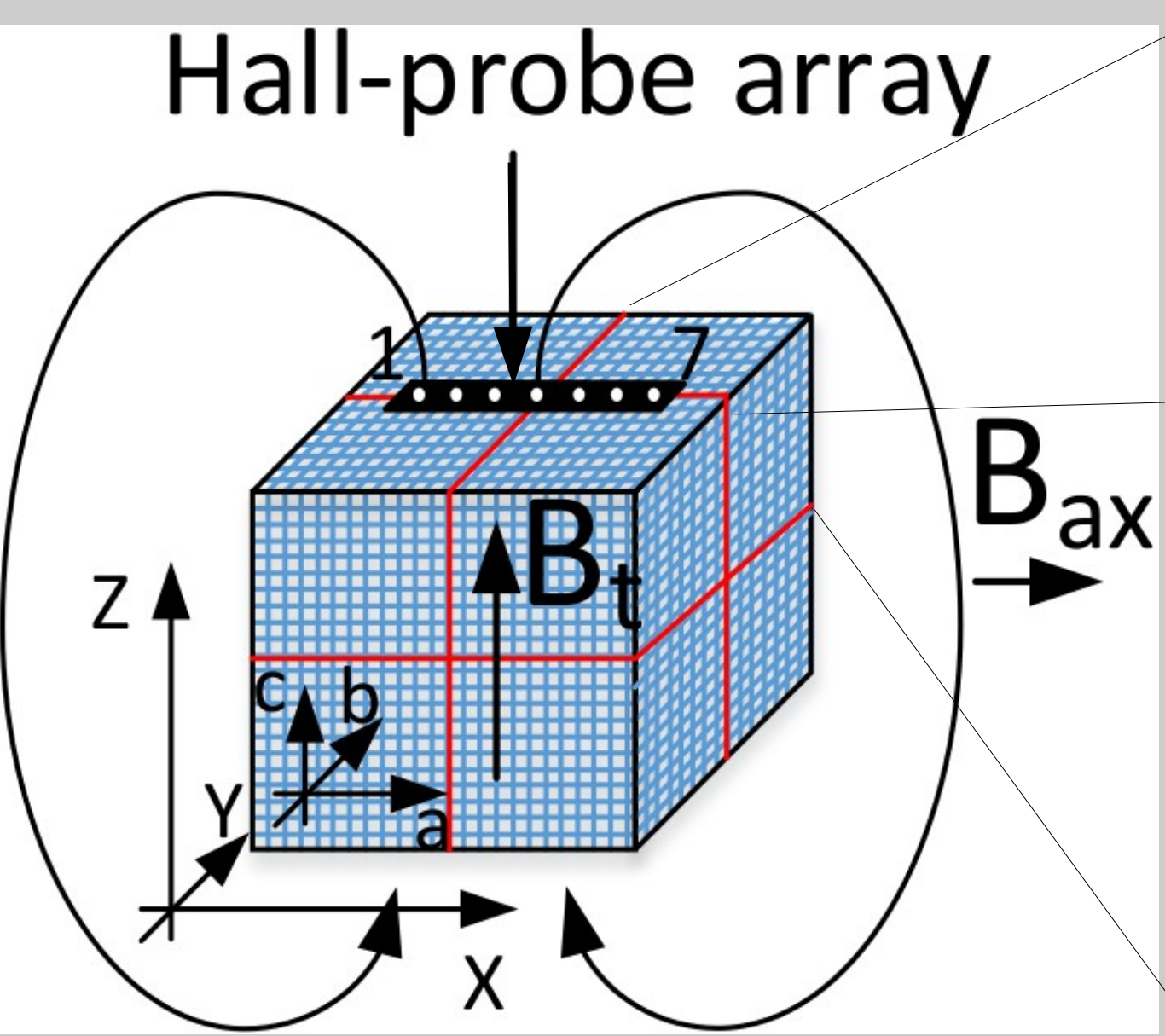


Set-up with Hall probe array

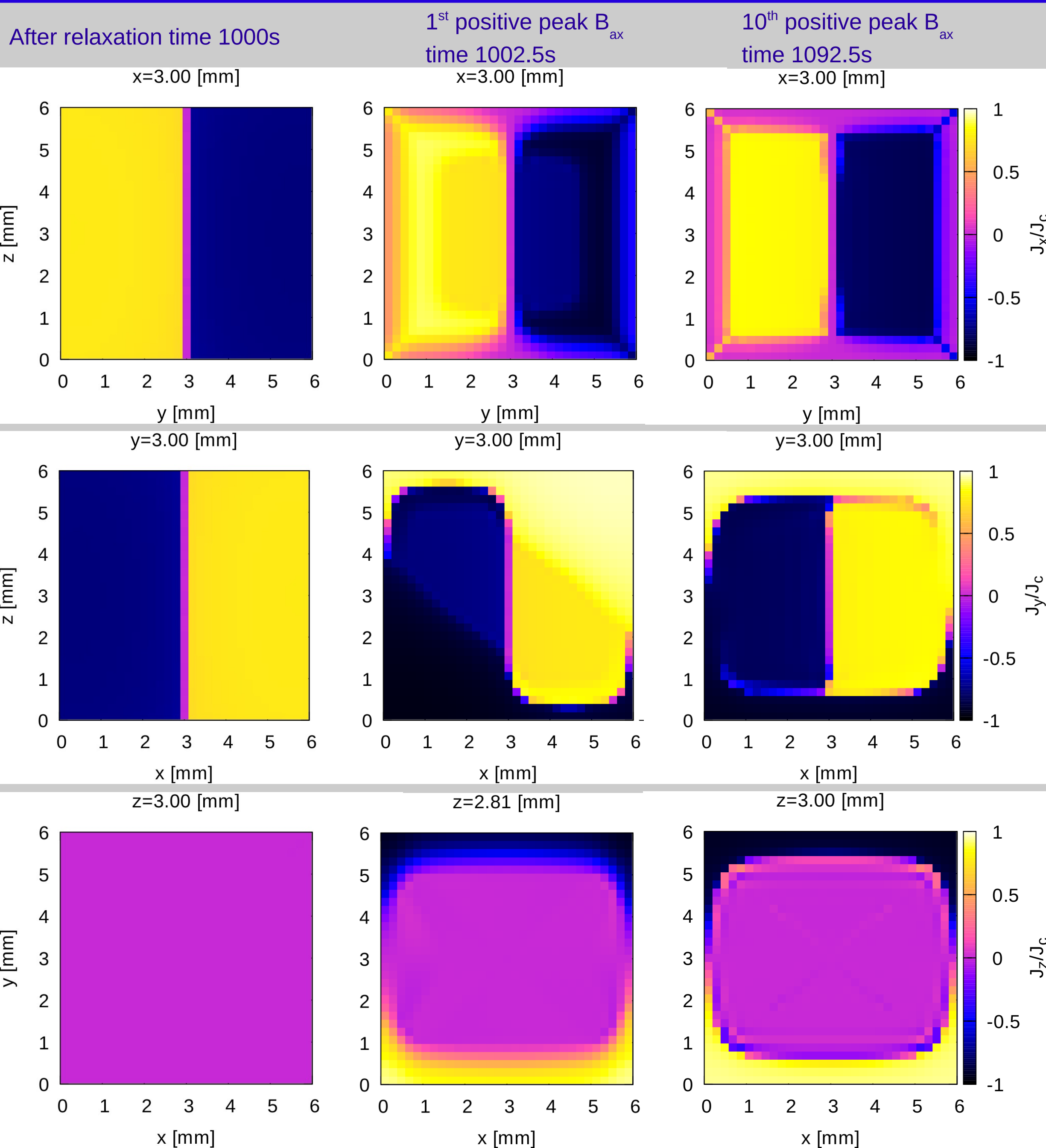
MEMEP 3D model

Isotropic power law

$$\mathbf{E}(\mathbf{J}) = E_c \left(\frac{|\mathbf{J}|}{J_c} \right)^n \frac{\mathbf{J}}{|\mathbf{J}|}$$



Parameters of models
Size 6x6x6 mm
 B_{az} 1.3 T
Ramp rate 13 mT/s
 B_{ax} 130 mT
 f_{ax} 0.1 Hz
Relaxation 900 s
 J_c 2.6×10^8 A/m²
N 30



The sample is fully saturated.

J_z erasing J_x at the edges of the sample

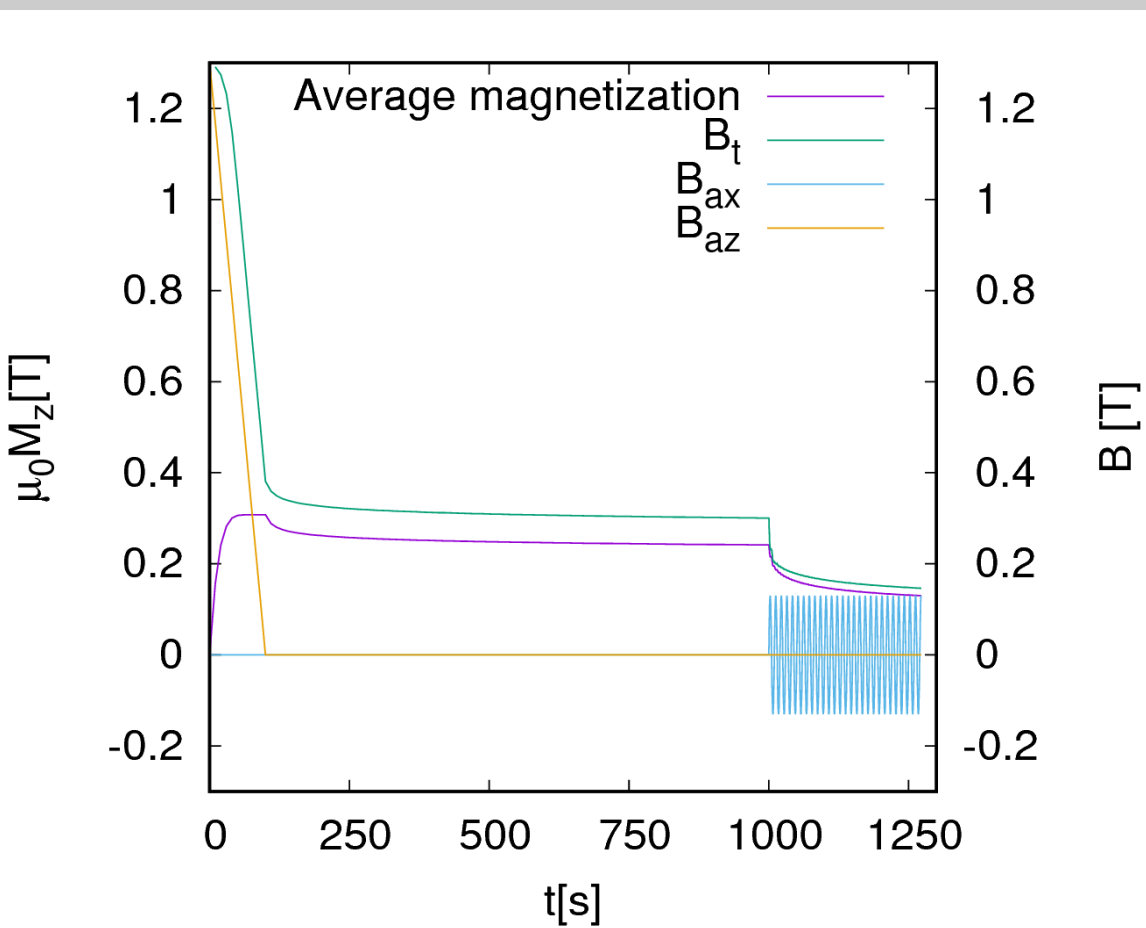
J_y profile has the same S-shape profile as 2D models

Ripples rewrite the initial screening currents and decrease trapped field

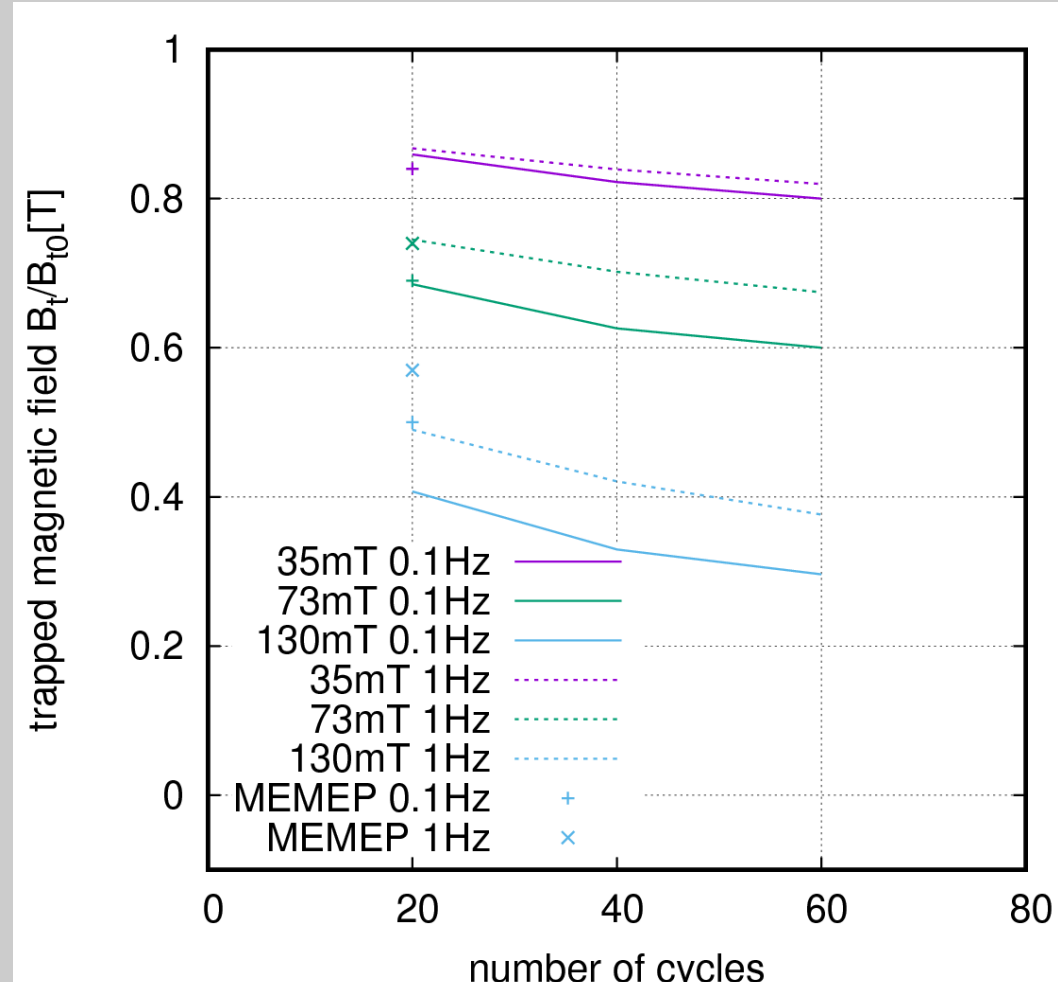
J is below J_c at the end of relaxation and where ripples do not penetrate

J_z is zero at the end of relaxation
At the 1st cycle of the ripple the current is smooth and at the 10th cycle is sharp

The waveform of applied magnetic field



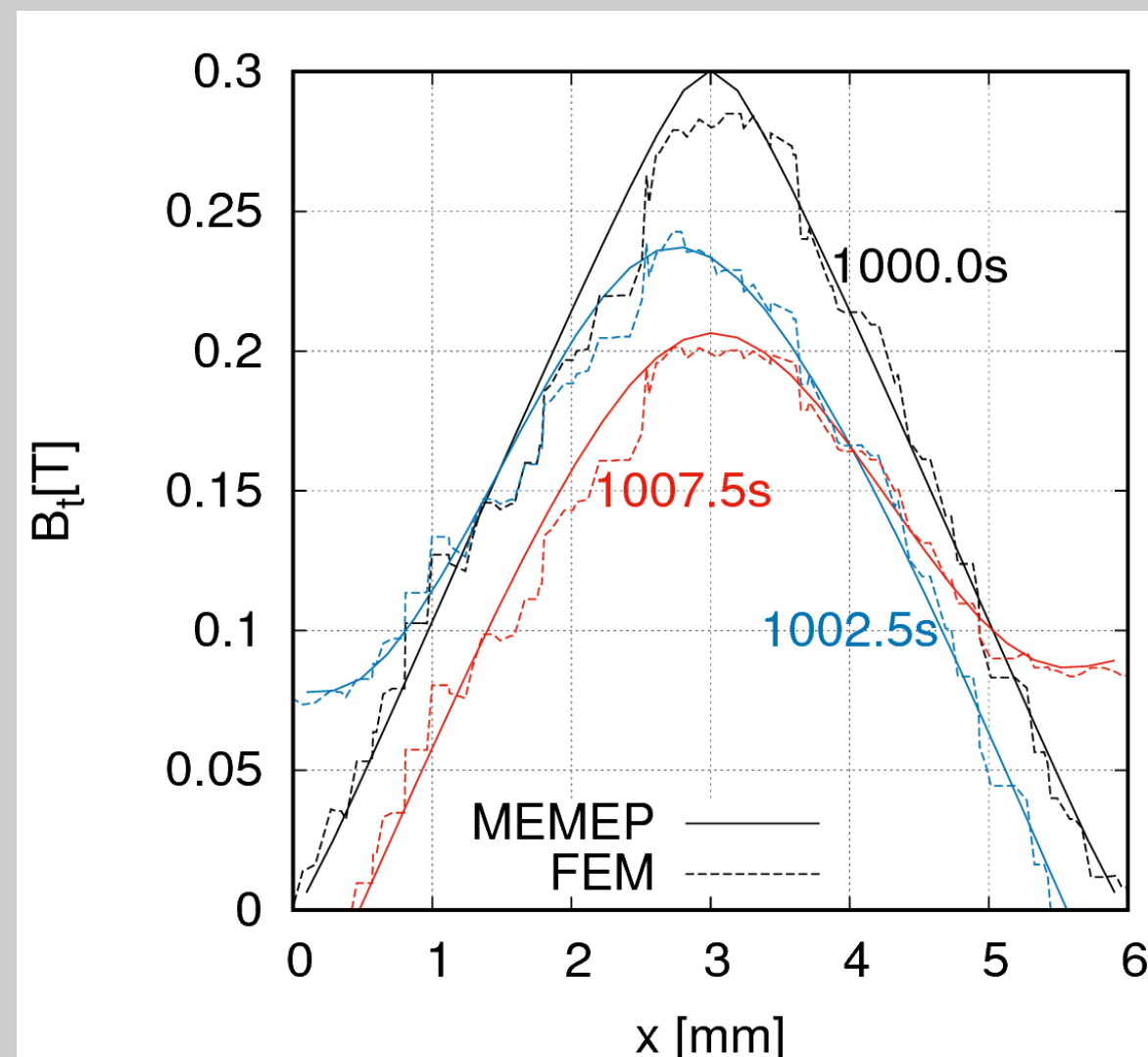
Measurement and calculation



Demagnetization decreases with frequency

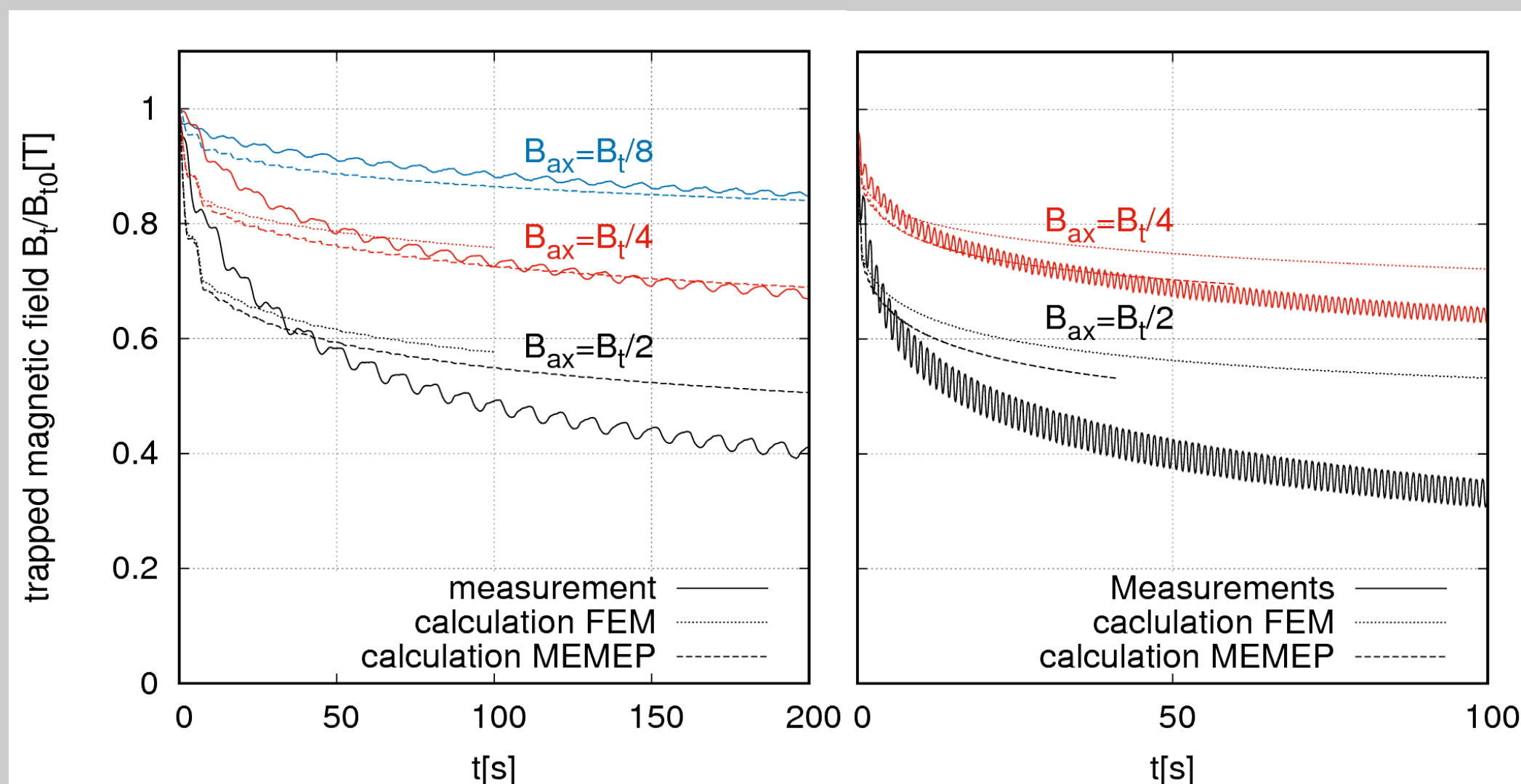
Comparison with FEM 3D model

The trapped field profile above the sample at different time: calculations



Both models confirmed asymmetry of trapped field.

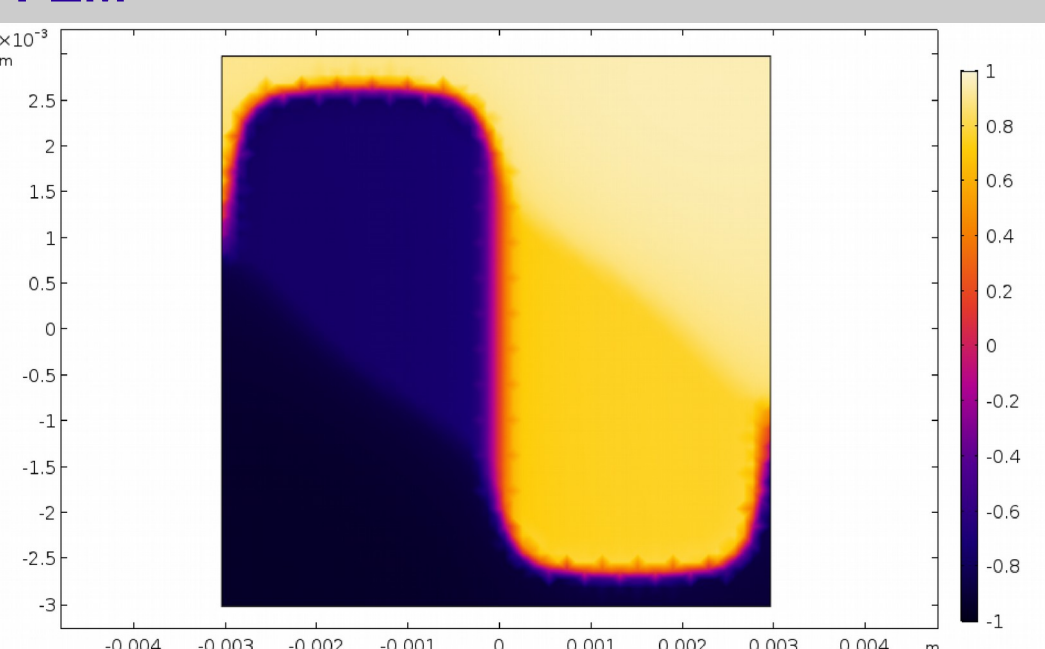
Decrease of trapped field at the center and 100 μm above the sample



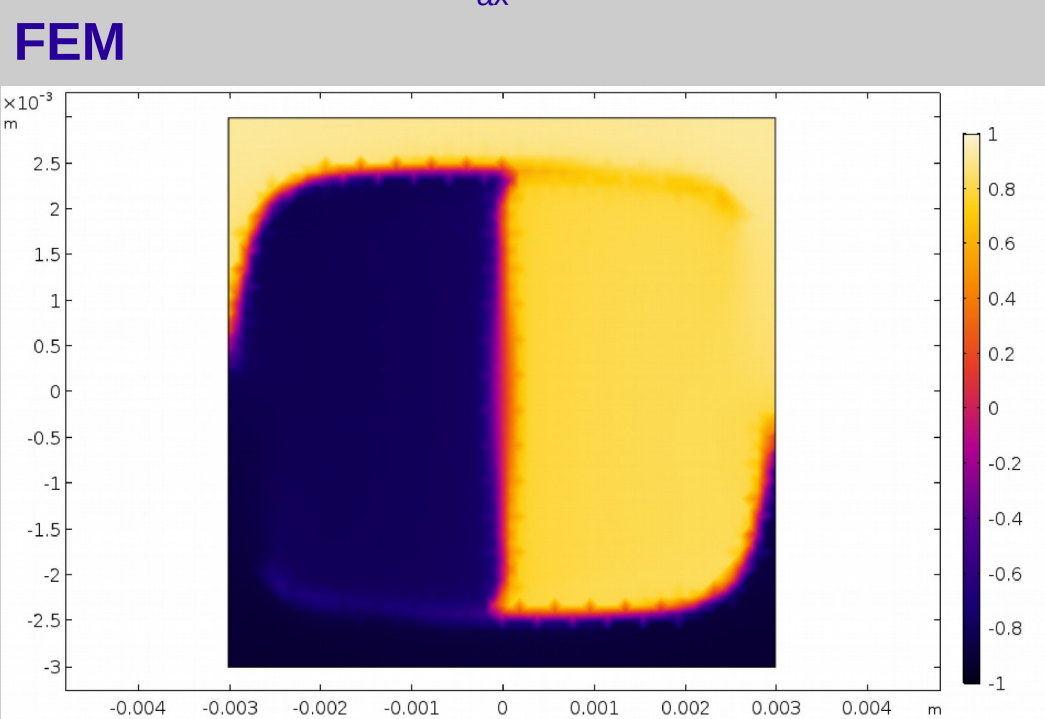
Models agree with measurements for low applied ripples $B_{ax}/B_t = 1/4, 1/8$

J_y component

1st positive peak B_{ax} time 1002.5s

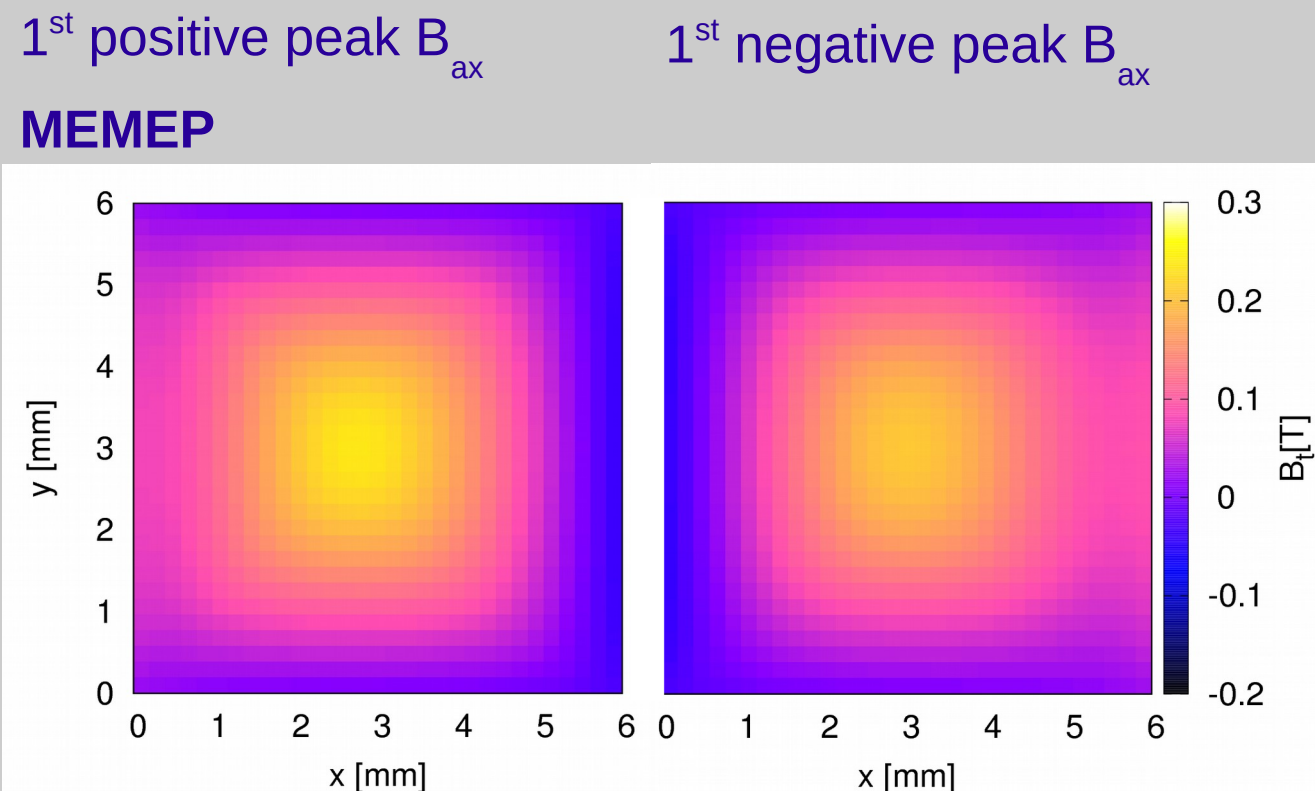


10th positive peak B_{ax} time 1092.5s

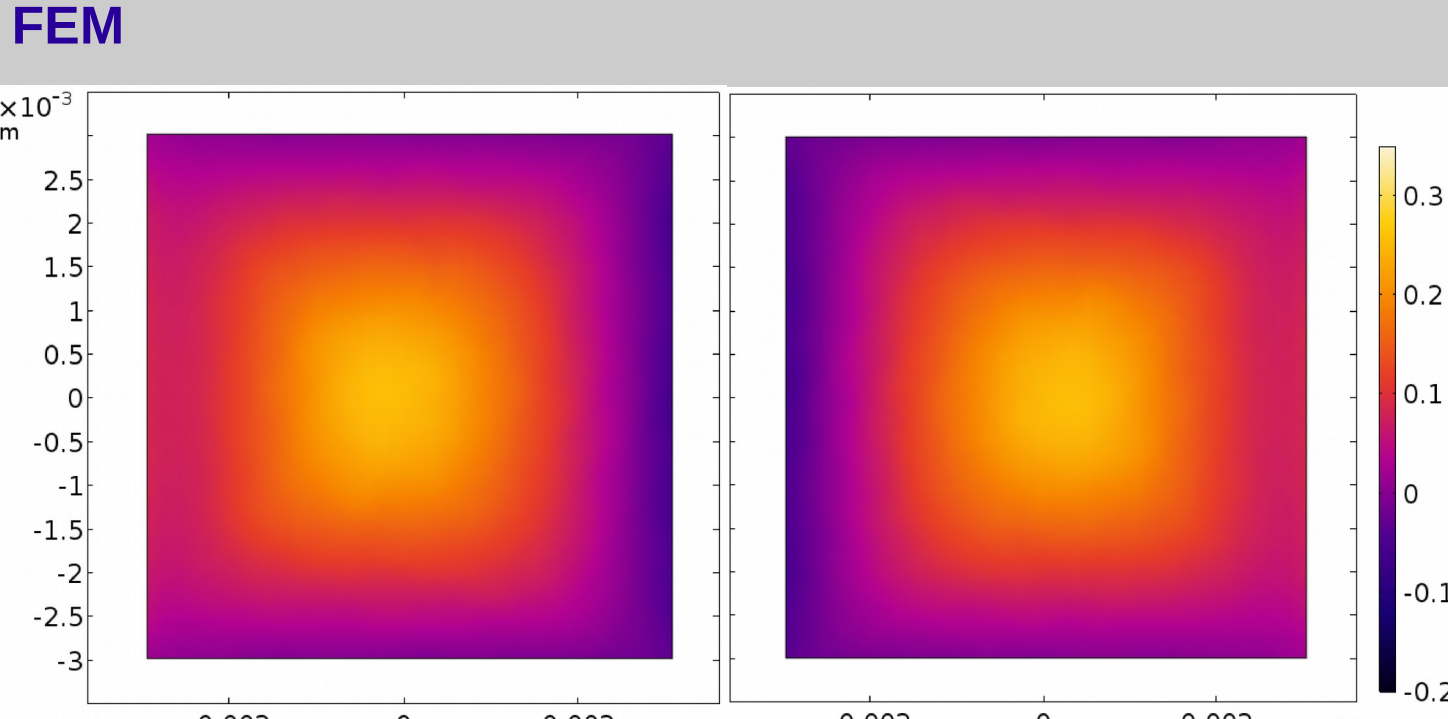


FEM qualitatively agree with MEMEP

Trapped field at plane 100 μm above the sample



Trapped field at plane on top of the sample



CONCLUSION

Demagnetization shows asymmetry of the trapped field

Screening current decrease below J_c and frequency dependence due to n-factor

MEMEP and FEM method agree well and show the same behavior of demagnetization

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